LUBRICATING DEVICE FOR A PLURALITY OF LUBRICATING STATIONS

FIELD OF THE INVENTION

The invention relates to a lubricating device for a plurality of lubricating stations, especially for supplying lubricant, preferably oil, to lubricating stations of a knitting machine.

BACKGROUND OF THE INVENTION

In knitting machines, for instance, the needle drive requires constant lubrication, which is equally true for the needle guide in the needle bed or needle cylinder, and so forth. Yet satisfactory, regular lubrication is extremely important, precisely in modern high-speed knitting machines. The lubricating stations must be reliably supplied with oil. As a rule, failure of the lubrication leads to increased wear and early failure of the knitting machine. On the other hand, the lubrication must be done in a thrifty way. It is counterproductive to supply too much oil to the lubricating stations. Such knitting machines are therefore often equipped with so-called pressure oilers or pressure oil lubricating systems, which feed oil under pressure from a central point to the individual lubricating stations via suitable lines.

A lubricating device for this purpose, known for instance from European Patent Disclosure EP 0 499 810 B1, permits reliable, metered lubrication of a plurality of lubricating stations. The lubricating device has a lubricant container in which a piston pump is accommodated. The output of the piston pump is connected to a motor-driven distributor valve, so that the pump outlet can be connected to one lubricant line at a time, selected from a group of lubricant lines.

It is an object of the invention to create a simplified lubricating device. It is another object of the invention to create an improved method of lubrication.

These and other objects are attained in accordance with one aspect of the invention directed to a lubricating device comprising a distributor device with which lubricant furnished by a pump is diverted to selected lines and can thus be delivered to selected lubricating stations. The distributor device and the pump device are combined into one unit. Combining the distributor device and the pump device into a unit makes for a considerably simpler design of the lubricating device. The triggering of the lubricating device can be simplified as well.

The pump device is embodied as a piston pump and has a piston that is axially displaceable in a cylinder. Together with the cylinder, this piston serves as a pumping element. The cylinder and the piston are also embodied as a control element. To that end, the piston is rotatably supported in the cylinder and is provided with control faces or conduits, with which control slots or outlets disposed in the cylinder are associated. The piston can be provided on its jacket face with at least one control conduit that is embodied in such a way that by suitable rotary positioning of the piston, it can be brought into coincidence with at least one of the outlet conduits at a time. If needed, the arrangement can also be made such that the control conduit can be switched into coincidence with a plurality of outlet conduits. The control conduit and the outlet conduits are disposed such that the work chamber, defined by the piston and the cylinder, communicates with whichever outlet conduit has been selected, over the entire stroke of the piston. In this way, all the oil volume positively displaced by the piston can be pumped into the outlet conduit. The piston pump embodied

in this way is both a pump device and distributor device at one and the same time.

The pump device and the distributor device can be connected to a drive device that effects the rotation and displacement of the piston. This displacement motion is a pumping motion, so that the displacement drive forms a pump drive. If no displacement motion occurs, the rotary motion of the piston causes no change in volume in the cylinder, and as a result, only the blocking or uncovering of outlet conduits is controlled by the rotary motion. Thus the rotary drive is a distributor drive, and the piston is a control slide. The pumping and switchover can thus each be effected independently, by rotating and displacing the piston. This can be done by means of separate drive devices, or by a combined drive device that is capable of generating both a rotary and a displacement motion.

For rotating the piston, a stepping motor is preferably used, which generates a desired rotary positioning motion. Rotary positions to be taken for selecting an outlet conduit and thus for activating a lubricating station are simple to attain with a stepping motor. However, the displacement motion of the piston can be derived from this stepping motor as well. To that end, the piston is preferably connected to the stepping motor or other kind of control motor via a coupling, which initially allows a set or adjustable rotary play, and the relative rotation within the rotary play is converted by a gear means into the desired linear motion.

The rotary angle of the rotary play can be utilized to generate a linear motion. To that end, the piston is preferably connected to a locking device, which keeps the piston nonrotatable in arbitrary or selected rotary positions, but without blocking its axial displacement. By way of example, this locking device can be formed by a locking wheel, which can be brought into and out of engagement with a locking member. This is preferably done by means of a suitable radial motion of the locking member, for instance by means of a pull magnet. If the piston is held in a manner fixed against relative rotation, then a rotation of the stepping motor within the context of the rotary play of the coupling device is possible. The displacement device is now preferably formed by a gear, which converts this relative rotation between the piston and the rotator device into a linear motion of the piston.

In an especially durable, simple embodiment, the locking wheel is embodied as a ratchet wheel. The locking element then acts as a pawl, which allows a rotation of the locking wheel in a selected direction. The pawl can also be releasable, for instance by a lifting magnet, to allow rotation of the locking wheel in the other direction. Such an arrangement allows normal operation of the lubricating device with only a very few actuations of the lifting magnet, used by way of example, for releasing and locking the paw. Even if simple, inexpensive lifting magnets are used, this makes a long service life possible.

The gear can be formed by two threaded elements meshing with one another. The pitch of the thread of the threaded elements is dimensioned such that by the relative rotation between the piston and the control motor, within the context of the rotary play of the coupling device, one complete piston stroke is executed. The piston can be moved back and forth by rotating the control motor forward and in reverse.

As needed, still other devices can serve as the gear means. For instance, it may be expedient to provide a cam drive, which enables a reciprocating motion of the piston upon rotation of the rotary drive in a single specified direction. Such a cam drive can be formed by an undulating annular

groove provided in the wall of a bush, in which groove a radially extending pin or prong runs, driven by the control motor.

The gear that generates the linear motion is preferably prestressed. This can for instance be accomplished by means of a magnet that keeps flanks of the gear that slide past one another in contact with one another. This is advantageous particularly with a view to correct metering of the lubricant. If the drive reverses its rotary direction, for instance to change from a forward piston stroke to a reverse piston stroke, then the turning points are precisely defined, and incorrect metering is avoided.

The outlet conduits leading out of the cylinder and one inlet conduit are each preferably provided with check valves. The pump device thus makes do without further control means. The check valves are preferably automatic valves, controlled by the differential pressure applied. No other valve control arrangements are needed.

For monitoring proper operation of the lubricating device, a sensor device that detects and monitors the reciprocating motion of the piston can be advantageous. It may suffice to monitor whether the piston attains a certain stroke or not. For instance, if one lubricating conduit is stopped up, the piston is unable to pump any lubricant into this conduit and is accordingly blocked. It fails to reach the switching point of the sensor device, and the sensor device detects this and turns off the affected machine.

Another aspect of the invention is directed to a method for the lubrication of lubricating stations of a machine by means of at least one pump via lines. Lubricant is pumped discontinuously by the pump to the lubricating stations via the lines. For lubricant supply to one or more lubricating stations, the applicable line or lines are subjected by the pump to a pressure that fluctuates over time. Regardless of the specific design of the pump device and distributor devices in attached lines, and regardless of how many lubricating stations are connected, it is expedient for the pump pressure to be modulated during individual lubricating pulses. If a stepping motor is used to drive the pump, its individual steps can be converted into micropumping pulses, whose train forms a lubricating pulse. The intervals between individual micropumping pulses are expediently dimensioned such that the pressure in the lines does not drop below a minimum limit value. The minimum pressure is preferably somewhat less than the requisite injection pressure for the connected nozzles. It suffices to keep any resilience (elasticity) of the lines under initial stress. This makes it possible either to meter especially small quantities of lubricant, or to prolong the lubricating process.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows the lubricating device in a schematic perspective view;

FIG. **2** shows the lubricating device of FIG. **1**, in a sectional view of a detail and on a different scale;

FIG. **3** is a horizontal section taken at line III—III of the cylinder body **8** of FIG. **7**, but with piston **21** assembled thereinto;

FIG. **4** is a horizontal section taken at line IV—IV of the lubricating device of FIG. **2**;

FIG. **5** is a plan view of a locking wheel belonging to the drive device of FIG. **4**;

FIG. **6** is a horizontal section through coupling device **39**, taken at line VI—VI in FIG. **7**, but with pin **42** assembled thereinto;

FIG. **7** shows a pump device, belonging to the lubricating device of FIG. **2**, with an associated coupling device, an associated locking wheel, and a threaded element for generating a linear motion;

FIG. **8** is a graph showing the course over time of the injection pressure of the oil stream flowing to an injection nozzle and the oil stream output by the injection nozzle;

FIG. **9** is a schematic plan view of a modified embodiment of a locking device with a locking wheel embodied as a ratchet; and

FIG. **10** is a schematic plan view of a further modified embodiment of a locking device with a locking wheel embodied as a ratchet.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. **1**, a lubricating device **1** is shown, which includes a supply container **2**, for lubricant, such as oil. A distributor and pump unit **3** is inserted into the supply container **2** and dispenses predetermined portions of lubricant at predetermined times to a group **4** of lubricant lines **5*a*** through **5*e*** that lead away from it.

The pump and distributor unit **3** schematically shown in FIG. **1** is shown separately in FIG. **2**. A piston pump **7**, which is both a pump device **7*a*** and a distributor device **7*b*** simultaneously is used for pumping and allocating the lubricant. The piston pump **7**, as seen particularly from FIGS. **3** and **7**, includes a cylinder body **8** with a cylindrical through bore **9**. The through bore **9** is embodied on its lower end in terms of FIGS. **2** and **7** as a stepped bore, because it has one portion **10** of increased diameter. This portion serves to receive a check valve **12**, whose valve body **14** is screwed for instance into a corresponding thread in the portion **10**.

The valve body **14** is provided with a through conduit **15** for receiving a valve closure member **16**. The head of the valve closure member **16** points toward the inner chamber, defined by the through bore **9**, of the cylinder body **8**. If needed, a spring, not shown, can brace the valve closure member against a valve seat embodied on the valve body **14**.

The valve body **14** is provided with a plurality of radial bores **17**, in the present example **12** of them (**17*a*–17*l***; FIG. **3**), which are all disposed in the same plane **18** to which the through bore **9** is perpendicular. The radial bores **17*a*–17*l*** FIG. **3**), which are disposed in the same plane **18** to which the through bore **9** is perpendicular. The radial bores **17*a*–17*l*** are disposed at equal angular spacings from one another, while the spacing between the radial bore **17*l*** and the radial bore **17*a*** is somewhat greater than the otherwise uniform spacings among the radial bores **17*a*** through **17*l***. Check valves, not identified by reference numeral, are inserted into the radial bores **17** (the reference numeral without a letter following it stands equally for all the radial bores **17*a*** through **17*l***), and these check valves allow a fluid flow in the radial direction outward, that is, from the bore **9** outward through the outlet conduit formed by the respective radial bore **17**, but not back again.

The lubricant lines **5*a*** through **5*e*** are connected to the outlet valves and lead to the lubricating stations. The check valves can be provided as needed also on an end of the respective line **5*a*** through **5*e*** remote from the distributor device **7*b***, in which case only connection nipples are screwed into the radial bores **17**.

A piston **21** is inserted into the through bore **9**, and its outer diameter substantially matches the inside diameter of the through bore **9**, so that while the piston is seated axially

displaceably and rotatably in the through bore **9**, it also together with the through bore defines a work chamber **22** relatively tightly (FIG. **2**). Along with its cylindrical jacket face **23**, the piston **21** also has a substantially plane end face **24**. A control groove **25** extends over the jacket face, beginning at the end face **24**, parallel to the center axis **26** of the piston. The length of the control groove **25** is preferably equal to or somewhat greater than the spacing of the plane **18** from a "top" dead center **27** of the piston; this point is represented by a dashed line in FIG. **2**.

The piston **21** reaches top dead center **27** with its end face **24** when the work chamber **22** is smallest, or in other words, in terms of FIG. **2**, when the piston **21** is in its bottommost position.

The control groove **25**, as FIG. **3** shows, is relatively narrow and extends in the circumferential direction along the jacket face **23** over a circumferential region that is approximately equivalent to the diameter of the radial bores **17** at the wall of the through bore **9**. The depth of the control groove **25** is dimensioned such that the flow resistance in the control groove **25** is not substantially greater than in the radial bores **17**.

On its end protruding out of the cylinder element **8**, the piston **21** is mounted in a connection cuff **29** and pinned to it (pin **30**). The connection cuff **29** is also connected via a further pin **31** to an actuating rod **32** that leads to a drive device **33**. The actuating rod **32** is connected in a manner fixed against relative rotation and solidly in the axial direction to a coupling half **34**, which has two ribs **35** and **36** extending axially and disposed parallel to and spaced apart from one another. Between these ribs, windows **37**, **38** are formed, which can be seen particularly in FIG. **6**.

The coupling half **34** belongs to a coupling device **39**, whose other coupling half **40** is formed by a radial pin **42** driven by a shaft **41**. This pin with both ends engages the windows **37**, **38**, and after each execution of a certain rotary play, here defined at 90°, it can come into contact with one flank of each of the ribs **35**, **36**.

The shaft **41** also has a bush **43**, which can be seen from FIG. **7** and establishes the connection to the radial pin **42** and is provided on its outside with a threaded element **44**. This threaded element has a male thread with multiple turns. Its pitch is dimensioned such that over 90° of the circumference of the threaded element **44**, a distance is traversed in the axial direction that corresponds to the complete piston stroke of the piston **21**.

During operation, the threaded element **44** is in communication with a threaded element **45**, which is seen in FIG. **5** and is embodied in an annular element or portion that is supported by the ribs **35**, **36** of the coupling half **34**. Thus when the rotary play of the coupling **39** is executed, the coupling half **34** changes its axial position relative to the coupling half **40**.

The portion of the coupling half **34** provided with the female thread (threaded element **45**) is embodied, on its outside, as a locking wheel **46**. This locking wheel has axially extending teeth **47** of approximately trapezoidal cross section, which serve to lock the coupling half **34** in a manner fixed against relative rotation but axially displaceably. This can be seen from FIG. **4**. A locking bar **48** is displaceably supported radially to the locking wheel **46**. The locking bar **48** is prestressed by a compression spring **49** toward its radially outer position, in which it is not in engagement with the locking wheel **46**. A lifting magnet **51** serves with its armature **52**, via a corresponding rod **53**, to put the locking bar **48** into engagement with the locking wheel **46**, so that the rotation of the locking wheel is blocked in discrete positions specified by the teeth **47**. These blocking or locking positions each correspond to rotary positions in which the control groove **25** (FIG. **3**) is aligned with one of the radial bores **17**. Accordingly, 13 interstices between teeth are present, 12 of which correspond to the positions of the radial bores **17**, and the 13th of which corresponds to the larger interstice between the radial bores **17*l*** and **17*a***. The size of the interstices between teeth corresponds to the size of the spacings of the radial bores **17**.

The coupling half **40** is connected in a manner fixed against relative rotation to the shaft **41**, which forms the power takeoff shaft of a stepping motor **55**. This motor is oriented coaxially to the actuating rod **32** and is supported by a corresponding mount **56**. The mount **56**, which is embodied in multiple parts, also carries the lifting magnet **51** and has a tubular, tapering extension **57**, which is disposed coaxially to the actuating rod **32** and carries the pump unit **7** on its lower free end. There, it has a flange-like extension **58**, on which the lubricant lines **5** can be retained and which moreover has a microporous sieve **59**. This sieve is embodied in cup-like shape and encloses the lower end of the extension **57**. The lubricant flowing to the inlet valve **12** must accordingly pass through the microporous sieve **59** and is thus filtered.

On its side toward the actuating rod **32**, the coupling half **34** is provided with a hub **60**, which has a male thread **61**. On the hub **60**, an annular, axially polarized permanent magnet **62**, shown separately in FIG. **7**, is retained with the aid of a nut **63**, for which nut the male thread **61** is intended. By means of its magnetic field, the permanent magnet **62** generates a force that keeps the threaded element **44** in engagement with the thread **45** without play. This serves to prevent an undesired idle motion in the gear at the reversal of the rotary direction of the stepping motor **55**; the gear is formed by the threaded element **44** and the female thread **45** and serves to convert a rotary motion into a linear motion.

The actuating rod **32** is supported on the extension **57** in a bush **65**, which is disposed adjacent the connecting cuff **29** in a corresponding partition of the extension **57**. The bush **65** allows both a rotary and an axial motion of the actuating rod **32**.

For monitoring the motion of the piston **21**, a magnetic sensor, for instance a Hall sensor **66**, is disposed on the inside of the extension **57**, adjacent to the permanent magnet **62**; it detects the position of the permanent magnet **62** and distinguishes between at least overshooting and undershooting a switching position. If needed, a further Hall sensor or other kind of position sensor **67** may be provided in the vicinity of the transverse pin **42**, in order to detect the position of this pin. Both the Hall sensors as well as the stepping motor **55** and the lifting magnet **51** are all connected to a control device, which controls the lubricating device **1** as follows:

For describing proper operation, it will be assumed that the piston **21** is initially in the position shown in FIG. **3**, and the locking bar **48**, as a consequence of triggering of the pull magnet **51**, is in engagement with the locking wheel **46** (FIG. **4**). If the thread of the threaded element **44** is a right-handed thread, then the stepping motor **55**, at least if the transverse pin **42** is not yet in the position represented by heavy lines in FIG. **6**, is now rotated in such a way that the transverse pin **42** is pivoted clockwise. For example, it is moved out of the position shown in dashed lines in FIG. **6** to the position shown in heavy lines. On traversing this course, the axially fixed element **44** lifts the coupling half **34**